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ภาคผนวก

ข้อมูลไฟล์ JCPDS เฟสของสารที่ปรากฏในการทดลอง

33-0875 wavelength = 1.54178

MgNb2O6

Magnesium Niobium Oxide

Magnocolumbite, syn

Rad.:CuKa λ:1.5417 Filter:Mono d-sp:Diffractometer

Cut off: Int.:Diffract. I/Icor.:

Ref:Roob, C., McCarthy, North Dakota State University, Fargo, North Dakota, USA, ICDD Grant-in-Aid,(1980)

Sys.:Orthorhombic S.G.:Pcan (60)

a:5.700(2) b:14.193(4) c:5.032(2 A:0.4016 C:0.3545

α: β: γ: Z:4 mp:

Ref:Ibid.

Dx:4.995 Dm: SS/FOM_3=27(.0161, 70)

MgO+Nb2O5 fired at 930 C for 22 hours, reground and fired at 1200 C for 18 hours. Columbite group, columbite subgroup. Silicon used as an internal stand. PSC:oP36. To replace 15-252 and 25-526. Mwt:306.11. Volume[CD]:407.09.

2θ	Int.	h	k	l
12.45	30	0	2	0
16.7	8	1	1	0
24.4	55	1(1)	1(3)	1(0)
25.05	15	0	4	0
30.3	100	1	3	0
31.2	10	2	0	2
33.85	2	2	2	1
35.65	10	0	0	2
36.2	10	2	0	1
38.0	5	0	6	0
38.4	2	2	2	1
39.6	2	1	1	2
40.6	6	2(0)	4(3)	0(2)
41.1	8	2	3	1
43.7	6	1	3	2
44.05	4	0	4	2
44.5	4	2	4	1
48.2	7	2	0	2

38-1459 wavelength = 1.5405981

Mg4Nb2O9

Magnesium Niobium Oxide

Rad.:CuKa λ:1.5405 Filter:Graph Mono d-sp:Diffractometer

Cut off:17.7 Int.:Diffract. I/Icor.:

Ref:Wong-Ng, W., McMurdie, H., Paretzkin, B., Hubbard, C., Dragoo, NBS(USA), ICDD Grant-in-Aid,(1986)

Sys.:Hexagonal S.G.:P3c1 (165)

a:5.1624(2) b: c:14.02402 A: C:2.7166

α: β: γ: Z:2 mp:

Ref:Wong-Ng, W et al., Powder Diffraction, 2, 111 (1987)

Dx:4.382 Dm: SS/FOM_3=75(.0117, 34)

Color:Colorless

Peak hight intensity. The mean temperature of data collection was 25.2 C. CAS#:12274-05-4.The sample was made by heating a 4:1 molar mixture of MgO and Nb2O5 at 1400 C for 3 days. To replace 36-1381 Mwt:427.03. Volume[CD]:323.67.

2θ	Int.	h	k	l
12.599	<1	0	0	2
19.817	73	1	0	0
23.575	24	1	0	2
25.365	9	0	0	4
32.415	100	1	0	4
34.720	45	1	1	0
37.079	1	1	1	2
38.507	9	0	0	6
39.843	22	1	1	3
40.321	7	2	0	0
42.384	2	2	0	2
43.497	18	1	1	4
43.632	13	1	0	6
47.856	<1	1	1	5
48.240	37	2	0	4
52.130	<1	0	0	8
52.777	25	1	1	6
54.240	5	2	1	0
54.667	<1	2	1	1

20-0681 wavelength = 1.7902

Mg5Nb4O15

Magnesium Niobium Oxide

Rad.:CoKa λ:1.7902 Filter:Fe Beta-M d-sp:

Cut off: Int.:Estimation I/Icor.:

Ref:Kasper, Z. Anong.Allg. Chem., 354,208 (1967)

Sys.:Orthorhombic S.G.:

a:11.427 b:10.058 c:10.26 A:1.1361 C:1.0201

α: β: γ: Z:4 mp:

Ref:Ibid.

Dx: Dm: SS/FOM$_3$=3(.036,287)

C.D. Cell: a=10.260, b=11.427, c=10.058, a/b=0.8979, c/b=0.8802, S.G.=. Mwt:73314. Volume[CD]:1179.21.

2θ	Int.	h	k	l
17.3	60	0	0	2
17.6	80	0	2	0
19.65	5	0	2	1
25.0	100	3	1	0
26.4	10	3	1	1
30.5	20	3	1	2
31.6	100	0	2	3
35.65	80	0	4	0
36.3	70	3	1	3
36.8	5	0	4	1
39.5	60	2	1	4
39.85	70	3	3	2
44.7	70	0	4	3
47.75	80	5	0	3
50.8	40	0	4	4

46-0001 wavelength = 1.540598

Na0.5Bi0.5TiO3

Sodium Bismuth Titanium Oxide

Rad.:CuKa λ:1.5405 Filter:Quartz Mono d-sp:Guinter

Cut off: Int.:film I/Icor.:

Ref: Zhou, F et al., Powder Diffraction, 4, 223 (1989)

Sys.:Monoclinic S.G.:P*/* (10)

a: 5.553(3) b: 6.675(3) c: 5.520(1) A: 0.8319 C: 0.8270

α: β:120.54(2) γ: Z: mp:

Ref:Ibid.

Dx: 5.987 Dm:5.934 SS/FOM$_3$=7(.0193, 149)

Color: Shallow yellow

Prepared form a mixure of Na2CO3, Bi2O3 and TiO2 heated at 800 C for 2 hours, then at 950 C for 4 hours. C.D. Cell: a=5.520, b=6.675, c=5.491, β=119.43, a/b=0.8270, c/b=0.8227, S.G.=P*/*. To replace 36-153. Mwt:211.88. Volume[CD]:176.22.

2θ	Int.	h	k	l
22.845	19	1	1	0
32.452	100	1	0	2
32.618	97	1	0(2)	1
40.020	7	2	1	0
40.230	24	0	1	2
46.698	66	2	2	0
52.280	3	2	1	3

27-1199 wavelength = 1.5418

Pb(MgO0.33Nb0.67)O3

Lead Magnesium Niobium Oxide

Rad.: CuKa λ: 1.5418 Filter: Mono d-sp:

Cut off: Int.: Diffract. I/Icor.:

Ref: Krause, H., Dept. Physics, Northern Illinois Univ., DeKalb, I11., USA, Private Communication, (1975)

Sys.: Cubic S.G.:Pm3m (221)

a: 4.049 b: c: A: C:

α: β: γ: Z: mp:

Ref: Krause, H., Gibbon, Z. Kristallogr., 134, 44 (1971)

Dx: Dm: SS/FOM_3=11(.076,21)

Color: Yellow

Sample from Dr. L.E. Cross, Materials Research Lab., Penn State University, University Park, Pennsyvania, UAS.

Mwt:325.47. Volume[CD]:66.38.

2θ	Int.	h	k	l
21.891	35	1	0	0
31.163	100	1	1	0
38.470	20	1	1	1
44.637	40	2	0	0
50.328	7	2	1	0
55.488	35	2	1	1
65.039	12	2	2	0

37-0071 wavelength = 1.5418

Pb1.83MgO0.29Nb1.71O6.39

Lead Magnesium Niobium Oxide

Rad.: CuKa λ: 1.5418 Filter: Mono d-sp: Diffractometer

Cut off: 22.1 Int.: Diffract. I/Icor.:

Ref: Shout, T., Swartz, Rev. Chim. Miner., 18, 663 (1983)

Sys.: Cubic S.G.:Fd3m (227)

a: 10.5988 b: c: A: C:

α: β: γ: Z: mp:

Ref: Ibid.

Dx: Dm: SS/FOM_3=72(.0110, 38)

Silicon used as internal stand. PSC: cF?. Mwt:647.33. Volume [CD]:1190.61.

2θ	Int.	h	k	l
14.473	5	1	1	1
23.726	<1	2	2	0
27.925	10	3	1	1
29.203	100	2	2	2
33.838	45	4	0	0
36.977	16	3	3	1
41.739	1	4	2	2
44.406	10	3	3	3
48.581	70	4	4	0
50.959	8	5	3	1
54.770	1	6	2	0

45-0946 wavelength = 1.5405

MgO

Magnesium Oxide

Periclase, syn

Rad.: CuKa1 λ: 1.5405 Filter: Ge Mono d-sp: Diffractometer

Cut off: Int.: Diffract. I/Icor.: 1.0

Ref: Kern, A.,Doetzer, R.,Eysel, W., Mineralogisch-Petrographisches Irrst., Univ. Heidelberg, Germany, ICDD Grant-in-Aid, (1993)

Sys.: Cubic S.G.: Fm3m (225)

a: 4.2112 b: c: A: C:

α: β: γ: Z: 4 mp:

Ref: Ibid.

Dx: 3.585 Dm: 3.560 SS/FOM_3=101(.0099,10)

Color: Colorless

Integrated intensities. MgO (Heraeus, 99.99%) annealed in open Au crucible at 800 C for 1 week. Validated by calculated pattern 43-1022. Cl Na type. Halite group, periclase subgroup. PSC:cF8. To replace 4-829. Mwt:40.30. Volume[CD]:74.68.

2θ	Int.	h	k	l
36.937	4	1	1	1
42.917	100	2	0	0
62.304	39	2	2	0
74.691	5	3	1	1

27-1199 wavelength = 1.5418

Pb2Bi4Ti5O18

Lead Bismuth Titanium Oxide

Rad.: CuKa λ: 1.5418 Filter: NI Beta d-sp:

Cut off: Int.: Diffract. I/Icor.:

Ref: Subbarao, J. Am. Ceram. Soc., 45, 166 (1962)

Sys.: tetragonal S.G.: I

a: 3.86 b: c: 49.7 A: C: 12.8756

α: β: γ: Z: mp:

Ref: Ibid.

Dx: Dm: SS/FOM_3=30(.0162,41)

PSC: tI?. Mwt:1777.81. Volume[CD]:740.51.

2θ	Int.	h	k	l
10.723	2	0	0	6
14.239	4	0	0	8
17.846	8	0	0	10
21.463	10	0	0	12
23.101	20	1	0	1
23.662	2	1	0	3
24.730	2	1	0	5
26.265	2	1	0	7
28.167	6	1	0	9
28.723	2	0	0	16
30.445	100	1	0	11
32.450	2	0	0	18
32.792	40	1	1	0
37.586	4	1	1	10
39.542	20	1	1	12
39.925	6	0	0	22
43.729	4	0	0	24
47.059	20	2	0	0
48.253	6	1	0	23
49.596	4	1	1	20

45-0946 wavelength = 1.5405981

MgO

Magnesium Oxide

Periclase, syn

Rad.:CuKa λ:1.5405 Filter:Ge Mono d-sp:Diffractometer

Cut off: Int.:Diffract. I/Icor.:1.0

Ref:Kern, A., Doetzer, R., Eysel, W.,

Mineralogisch-Petrographisches Inst., Univ. Heideberg,

Germany, ICDD Grant-in-Aid, (1993)

Sys.:Cubic S.G.:Fm3m (255)

a:4.2112 b: c: A: C:

α: β: γ: Z:4 mp:

Ref:Ibid.

Dx: 3.585 Dm: 3.560 SS/FOM$_3$=101 (.0099, 10)

Color: Colorless

Integrated intensities. MgO (Heraeus,99.99%) annealed in open Au crucible at 800 C for 1 week. Validated by calculateed patten 43-1022. Cl Na type. Halite group, periclase subgroup. Silicon used as an internal stand. PSC: cF8. To replace 4-829. Volume[CD]:74.68.

2θ	Int.	h	k	l
36.937	4	1	1	1
42.917	100	2	0	0
62.304	39	2	2	0
74.691	5	3	1	1
78.630	10	2	2	2
94.052	8	4	0	0
105.734	2	3	3	1
109.765	19	4	2	0
127.285	14	4	2	2
143.754	4	5	1	1

07-0239 wavelength = 1.54056

Mg(OH)2

Magnesium Hydroxide

Brucite, syn

Rad.:CuKa λ:1.5405 Filter:Ni Beta-M d-sp:

Cut off: Int.:Diffract. I/Icor.:1.6

Ref:Natl. Bur. Stand. (U.S.), Circ. 539,6, 30(1956)

Sys.:Hexagonal S.G.:P3m1 (164)

a:3.147 b: c:4.769 A: C:1.5154

α: β: γ: Z:1 mp:

Ref:Ibid.

Dx: 2.368 Dm: 3.560 SS/FOM$_3$=28(.029, 32)

εα: 1.561 ηωβ: 1.581 εγ: Sign:+ 2V:

Ref: Ibid.

Color: Colorless

Pattern taken at 26 C. Sample Prepared at NBS, Gaithersburg, MD, USA, form MgO and water held at 600 C and 20,000 psi for 3 days. Spectroscopic analysis shows (wt.%):Ca<0.1, Ag, B Fe, Si, Ti<0.01,BaCr,Cu<0.001. Cd I2 type. Brucite group, brucite subgroup. PSC:hP5.

Mwt: 58.32 Volume[CD]:40.90.

2θ	Int.	h	k	l
18.586	90	0	0	1
32.839	6	1	0	0
38.016	100	1	0	1
50.854	55	1	0	2
58.640	35	1	1	0
62073	18	1	1	1
68.253	16	1	0	3
68.823	2	2	0	0
72.030	12	2	0	1
80.513	2	0	0	4
81.253	10	2	0	2
87.099	2	1	1	3
89.721	4	1	0	4
96.310	6	2	0	3
96.808	2	2	1	0
99.841	8	2	1	1
107.640	2	0	0	5

Reference pattern: 30-0872

Name : **Niobium Oxide**

Formula : **Nb2O5**

Elements : **O, Nb**

Groups : **—**

Crystal type : **?**

Subfiles : **Inorganic, Alloys**

Pattern deleted : **No**

d value	Angle	Relative Intensity
5.12	17.306	20
4.88	18.164	10
4.63	19.154	20
3.86	23.022	10
3.75	23.707	100
3.64	24.435	60
3.57	24.921	80
3.49	25.502	60
3.36	26.507	30
3.16	28.218	10
2.83	31.589	50
2.77	32.292	60
2.70	33.153	30
2.54	35.308	50
2.49	36.041	40
2.3	38.958	60
2.07	43.694	30
2.05	44.142	40
2.04	44.370	30
1.91	47.569	80
1.78	51.285	30
1.70	53.888	10

ผลการวิเคราะห์ XRD ของวิธีกึ่งเชิงปริมาณโดยการเติมซิลิกอนเป็นสารมาตรฐาน

Data : $MgO:Nb_2O_5$ 3.5:1 1350 °C/3h, 2nd

rate : 0.5 deg/min

Peak data list

Peak no.	2Theta (deg.)	d (A)	I/I1	FWHM (deg.)	Intensity (Counts)	Integrated Int. (counts)
1	24.4562	3.63685	48	0.15360	4061	14288
2	24.8000	3.58721	14	0.11640	1153	3695
3	25.0384	3.55359	98	0.17790	8311	32889
4	25.4375	3.49873	5	0.25750	390	2929
5	26.5295	3.35714	4	0.22750	367	2107
6	28.5060	3.12871	85	0.15580	7203	25264
7	30.3118	2.94630	80	0.15430	6787	23110
8	30.6016	2.91906	12	0.14070	1002	5880
9	31.3500	2.85106	6	0.14640	520	3115
10	31.6691	2.82306	100	0.14760	8488	27914
11	32.4833	2.75413	12	0.15040	1026	3911
12	34.7948	2.57628	6	0.15460	545	2122
13	35.7212	2.51156	53	0.14800	4506	14879
14	36.2000	2.47943	12	0.09680	1008	1999
15	36.4596	2.46237	36	0.14320	3014	11585
16	36.8032	2.44016	3	0.19360	259	942
17	38.0038	2.36579	5	0.23230	399	2611
18	39.4646	2.28152	18	0.13090	1529	4562
19	39.9561	2.25458	31	0.14150	2612	8369
20	40.6029	2.22014	6	0.14000	534	21152314
21	41.0892	2.19498	8	0.14580	649	3135
22	43.7228	2.06868	8	0.16380	698	1766
23	44.1165	2.05113	4	0.20340	358	11515
24	44.7518	2.02348	42	0.14420	3566	11501
25	47.3723	1.91747	37	0.15380	3173	15913
26	47.8162	1.90070	51	0.16110	4316	5792

Data : $MgO:Nb_2O_5$ 1:1 1200 °C/3h

rate : 0.5 deg/min

Peak data list

Peak no.	2Theta (deg.)	d (A)	I/I1	FWHM (deg.)	Intensity (Counts)	Integrated Int. (counts)
1	22.6265	3.92664	56	0.31240	5093	32754
2	23.7697	3.74031	16	0.28670	1448	10651
3	34.4666	3.63533	37	0.22970	3352	19996
4	24.8500	3.58010	10	0.00000	919	0
5	25.1000	3.54501	14	0.36060	1321	8701
6	25.5000	3.49030	7	0.50640	650	8580
7	27.9000	3.19527	3	0.22060	298	2727
8	28.4188	3.13811	100	0.32550	9173	59235
9	28.9918	3.07738	43	0.20590	3905	15944
10	29.3000	3.04570	4	0.14220	382	1942
11	30.3287	2.94470	67	0.20660	6183	27796
12	31.4179	2.84505	8	0.22210	711	3166
13	32.2000	2.77771	5	1.04920	467	5522
14	32.4500	2.75688	6	0.26860	512	1987
15	32.8367	2.72529	4	0.24900	342	2173
16	35.6950	2.51334	9	0.22030	817	4921
17	36.1500	2.48274	6	0.30520	588	4679
18	36.5827	2.45436	41	0.19960	3788	5370
19	37.0767	2.42279	17	0.20880	1577	6893
20	38.0413	2.36354	3	0.21110	289	1639
21	38.9185	2.31227	4	0.19020	364	1810
22	40.6265	2.21891	4	0.22250	381	1830
23	41.1161	2.19361	5	0.21680	463	2225
24	42.6000	2.12057	4	0.30540	343	2652
25	42.9457	2.10430	8	0.28020	692	3876
26	43.7544	2.06726	6	0.28060	541	3278

Data : $MgO:Nb_2O_5$ 1:1 1100 °C/3h, 2nd

rate : 0.5 deg/min

Peak data list

Peak no.	2Theta (deg.)	d (A)	I/I1	FWHM (deg.)	Intensity (Counts)	Integrated Int. (counts)
1	23.7715	3.74003	19	0.22140	3198	16477
2	24.4658	3.63545	53	0.17460	8936	40420
3	24.8000	3.58721	9	0.00000	1497	0
4	25.1500	3.53807	17	0.15500	2824	17715
5	25.5500	3.48358	8	0.27580	1334	11448
6	28.4954	3.12985	39	0.15010	6584	21647
7	30.3345	2.94415	100	0.14960	16789	61618
8	31.4135	2.84544	11	0.15980	1898	8032
9	31.6500	2.82472	3	0.00000	586	0
10	32.1000	2.78614	5	0.56260	823	8070
11	32.2500	2.77352	5	0.00000	821	0
12	32.4783	2.75454	7	0.18320	1118	6577
13	35.3213	2.53907	3	0.24260	545	4238
14	35.6958	2.51329	14	0.15300	2401	8498
15	36.2394	2.47682	13	0.15560	2266	8330
16	38.0390	2.31259	6	0.20230	1005	5413
17	38.9128	2.21884	6	0.17850	934	4911
18	40.6278	2.19393	7	0.14700	1158	4184
19	41.1099	2.10309	10	0.14400	1733	5546
20	42.9717	2.07422	4	0.15070	599	2454
21	43.6000	2.06772	3	0.15740	551	2243
22	43.7441	2.05243	10	0.17470	1731	5227
23	44.0870	2.03095	8	0.30130	1284	8153
24	44.5782	1.91833	5	0.19030	808	3932
25	47.3500	1.91072	16	0.12260	2683	7879
26	47.5500	1.88399	13	0.14000	2129	7771

ประวัติผู้วิจัย

นาย ปฤงคพ เหมพันธุ์พิรุฬห์ เกิดเมื่อวันที่ 1 ธันวาคม พ.ศ. 2516 สำเร็จการศึกษาระดับปริญญาตรี วิทยาศาสตรบัณฑิต สาขาเคมีอุตสาหกรรม ภาควิชาเคมีอุตสาหกรรม มหาวิทยาลัยเชียงใหม่ เมื่อปีการศึกษา 2539 เข้าศึกษาต่อในหลักสูตรวิทยาศาสตรมหาบัณฑิต สาขาเทคโนโลยีเซรามิก ภาควิชาวัสดุศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย ในปีการศึกษา 2539 และสำเร็จหลักสูตรในเดือน เมษายน พ.ศ. 2542